

## CLAIMS

I claim:

Sub A17 1. A module in an audio communications system, comprising:  
2 a first input for receiving a first audio signal;  
3 a second input for receiving a second audio signal, wherein at least a portion  
4 of the second audio signal is an echo of the first audio signal;  
5 a distortion module receiving the first audio signal, the distortion module  
6 adapted to model a distortion on the first audio signal and produce a  
7 distorted signal; and  
8 an adder module for receiving the distorted signal and the second audio signal  
9 and adapted to use the distorted signal to remove at least part of the  
10 echo from the second audio signal.

1 2. The module of claim 1, wherein the first and second audio signals bear  
2 sequencing information and wherein the adder module is adapted to use the sequencing  
3 information to remove at least part of the echo from the second audio signal.

1 3. The module of claim 1, further comprising:  
2 an audio generation module receiving the first audio signal and adapted to use  
3 the distortion module to model a distortion that occurs responsive to  
4 playing the first audio signal through a loudspeaker.

1 4. The module of claim 3, wherein the audio generation module comprises:  
2 a modeling path having one or more distortion modules that model distortions  
3 on the first audio signal.

1 5. The module of claim 4, wherein each distortion module models a different  
2 type of distortion.

1 6. The module of claim 4, wherein the audio generation module alters the  
2 modeling path in real-time responsive to distortions that may occur on the first audio  
3 signal.

1 7. The module of claim 3, wherein the distortion module models an effect of  
2 amplifier clipping on the first audio signal.

1 8. The module of claim 3, wherein the distortion module models an effect of  
2 voice coil displacement on sound pressure waves produced by the loudspeaker responsive  
3 to the first audio signal.

1 9. The module of claim 3, wherein the distortion module models an effect of  
2 hysteresis in an iron core inductor on the first audio signal.

1 10. The module of claim 3, wherein the distortion module models an effect of  
2 harmonic distortion on sound pressure waves produced by the loudspeaker responsive to  
3 the first audio signal.

1 11. The module of claim 1, further comprising:  
2 an acoustic echo estimation module receiving the first audio signal and for  
3 adapting the first audio signal to compensate for substantially linear  
4 changes in the second audio signal.

1 12. The module of claim 1, further comprising:  
2 an audio sensing module receiving the first audio signal and adapted to use the  
3 distortion module to model a distortion that occurs responsive to  
4 sensing the second audio signal.

1 13. The module of claim 12, wherein the audio sensing module comprises:  
2 a modeling path having one or more distortion modules that model distortions  
3 on the second audio signal.

1 14. The module of claim 13, wherein each distortion module models a  
2 different type of distortion.

1 15. The module of claim 13, wherein the audio sensing module alters the  
2 modeling path in real-time responsive to distortions that may occur on the second audio  
3 signal.

1 16. The module of claim 12, wherein the distortion module models an effect  
2 of microphone centerclipping on the second audio signal.

1 17. The module of claim 12, wherein the distortion module models an effect  
2 of amplifier zero crossing distortion on the second audio signal.

1 18. The module of claim 1, wherein the distortion module models a pre-  
2 established distortion.

1 19. The module of claim 1, wherein the distortion module is adaptive.

1 20. The module of claim 1, wherein the distortion module models a nonlinear  
2 distortion.

1 21. The module of claim 1, wherein the distortion module operates in a  
2 frequency domain.

1 ~~22.~~ A method of canceling an echo in an audio signal, comprising the steps of:  
2 receiving a first audio signal;  
3 receiving a second audio signal, wherein at least a portion of the second audio  
4 signal is a distorted echo of the first audio signal;  
5 modeling one or more types of distortions on the first audio signal to produce  
6 a distorted audio signal; and

7 subtracting the distorted audio signal from the second audio signal to at least  
8 partially cancel the distorted echo of the first audio signal from the  
9 second audio signal.

1 23. The method of claim 22, wherein the modeling step comprises the step of:  
2 adaptively modeling one or more types of distortion.

1 24. The method of claim 22, wherein the modeling step comprises the step of:  
2 modeling a pre-established type of distortion.

1 25. The method of claim 22, further comprising the step of:  
2 retrieving sequencing information from the first and second audio signals;  
3 wherein the subtracting step uses the sequencing information to at least  
4 partially cancel the distorted echo of the first audio signal from the  
5 second audio signal.

1 26. The method of claim 22, wherein the modeling step comprises the step of:  
2 passing the first audio signal through a modeling path comprising one or more  
3 distortion modules, each distortion module applying a type of  
4 distortion to the first audio signal.

1 27. The method of claim 26, wherein the modeling path models distortions  
2 that occur responsive to playing the first audio signal through a loudspeaker.

1 28. The method of claim 27, wherein the passing step comprises the step of:  
2 passing the first audio signal through a distortion module that models an effect  
3 of amplifier clipping on the first audio signal.

1 29. The method of claim 27, wherein the passing step comprises the step of:  
2 passing the first audio signal through a distortion module that models an effect  
3 of voice coil displacement on sound pressure waves produced by the  
4 loudspeaker responsive to the first audio signal.

1 30. The method of claim 27, wherein the passing step comprises the step of:  
2 passing the first audio signal through a distortion module that models an effect  
3 of harmonic distortion on the sound pressure waves produced by the  
4 loudspeaker responsive to the first audio signal.

1 31. The method of claim 27, wherein the passing step comprises the step of:  
2 passing the first audio signal through a distortion module that models an effect  
3 of hysteresis in inductors containing iron on the first audio signal.

1 32. The method of claim 26, wherein the modeling path models distortions  
2 that occur responsive to sensing the second audio signal.

1 33. The method of claim 32, wherein the passing step comprises the step of:  
2 passing the first audio signal through a distortion module that models an effect  
3 of microphone centerclipping on the second audio signal.

1 34. The module of claim 32, wherein the passing step comprises the step of:  
2 passing the first audio signal through a distortion module that models an effect  
3 of amplifier zero crossing distortion on the second audio signal.

1 ~~35.~~ A terminal for an audio communications system, the terminal comprising:  
2 a loudspeaker for producing sound pressure waves responsive to a received  
3 first signal;

4 a microphone for converting sound pressure waves into a second signal,  
5 wherein a portion of the second signal represents an echo of the sound  
6 pressure waves produced by the loudspeaker;  
7 a distortion module receiving the first signal and adapted to modify the first  
8 signal to model a type of distortion to produce a distorted signal; and  
9 an adder module for removing at least a portion of the echo of the sound  
10 pressure waves produced by the loudspeaker from the second signal  
11 responsive to the distorted signal.

1 36. The terminal of claim 35, wherein the first and second signals bear  
2 sequencing information and wherein the echo cancellation module is adapted to use the  
3 sequencing information to remove at least part of the echo from the second signal.

1 37. The terminal of claim 35, further comprising:  
2 an audio generation module receiving the first signal and adapted to use the  
3 distortion module to model a distortion that occurs responsive to  
4 playing the first signal through the loudspeaker.

1 38. The terminal of claim 37, wherein the audio generation module has a  
2 modeling path comprising one or more distortion modules that model distortions on the  
3 first signal.

1 39. The terminal of claim 38, wherein each of the one or more distortion  
2 modules models a different type of distortion.

1 40. The terminal of claim 38, wherein the audio generation module alters the  
2 modeling path in real-time responsive to distortions that may occur on the first signal.

1 41. The terminal of claim 37, wherein the distortion module models an effect  
2 of amplifier clipping on the first signal.

1           42.     The terminal of claim 37, wherein the distortion module models an effect  
2 of voice coil displacement on the sound pressure waves produced by the loudspeaker.

1           43.     The terminal of claim 37, wherein the distortion module models an effect  
2 of hysteresis in an iron core inductor on the first signal.

1           44.     The terminal of claim 37, wherein the distortion module models an effect  
2 of harmonic distortion introduced by the loudspeaker on the sound pressure waves.

1           45.     The terminal of claim 35, further comprising:  
2                 an acoustic echo estimation module receiving the first signal and for adapting  
3                 the first signal to compensate for substantially linear changes in the  
4                 second signal.

1           46.     The terminal of claim 35, further comprising:  
2                 an audio sensing module receiving the first signal and adapted to use the  
3                 distortion module to model a distortion that occurs responsive to  
4                 sensing the audio signal.

1           47.     The terminal of claim 46, wherein the audio sensing module has a  
2 modeling path comprising one or more distortion modules that model distortions on the  
3 second signal.

1           48.     The terminal of claim 47, wherein each of the one or more distortion  
2 modules models a different type of distortion.

1           49.     The terminal of claim 47, wherein the audio sensing module alters the  
2 modeling path in real-time responsive to distortions that may occur on the second audio  
3 signal.

1           50.     The terminal of claim 46, wherein the distortion module models an effect  
2 of microphone centerclipping on the second signal.

1           51.     The terminal of claim 46, wherein the distortion module models an effect  
2 of amplifier zero crossing distortion on the second signal.